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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re the Application of: **HIROOKA, et al.**

Group Art Unit: **1746**

Serial No.: **09/337,278**

Examiner: **WINTER, G,**

Filed: **June 22, 1999**

P.T.O. Confirmation No.: 8796

For. **CLEANING AND HANDLING METHODS OF ELECTRONIC COMPONENT AND CLEANING APPARATUS THEREOF**

REQUEST FOR ORAL HEARING

Commissioner for Patents
Washington, D. C. 20231

Date: December 23, 2002

Sir:

Applicants hereby request an Oral Hearing before the Board of Appeals, in connection with the above-identified application. This Request is being timely filed.

1-9-03

Enclosed please find our check in the amount of $ **280.00** for the fee herein.

In the event that this paper is not timely filed, applicants hereby petition for an appropriate extension of time. The fee for any such extension may be charged to our Deposit Account No. 01-2340.

In the event that any additional fees are due in connection with this paper, please charge our Deposit Account No. 01-2340. A duplicate copy of this paper is enclosed.

Respectfully submitted,

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1st 1710

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re the Application of: **HIROOKA, et al.**

Group Art Unit: **1746**

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For. **CLEANING AND HANDLING METHODS OF ELECTRONIC COMPONENT AND CLEANING APPARATUS THEREOF**

SUBMISSION OF REPLY BRIEF

Commissioner for Patents
Washington, D.C. 20231

December 23, 2002

Sir:

Submitted herewith are an original and two copies of an Reply Brief in the above-identified U.S. patent application. Also attached is a Request for Oral Hearing.

In the event that any fees are due with respect to this paper, please charge Deposit Account No. 01-2340. This paper is filed in triplicate.

Respectfully submitted,

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Enclosures: Duplicate of this paper; and Reply Brief and two copies; and
Request for Oral Hearing

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

REPLY BRIEF

Ex parte **HIROOKA et al.** (applicants)

CLEANING AND HANDLING METHODS OF ELECTRONIC COMPONENT AND CLEANING APPARATUS THEREOF

Serial Number: **09/337,278**

Filed: **June 22, 1999**

Appeal No. :

Group Art Unit: **1746**

Examiner: **G. Winter**

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Date: **December 23,2002**

Atty. Docket No. 990659

REPLY BRIEF

This reply is filed in response to the Examiner's Answer dated October 23, 2002.

On page 4 of the Examiner's answer, the Examiner disagrees that claims 9 and 10 do not stand or fall together. Claim 10, however, is a multiple dependent claim whereas claim 9 is an independent claim. Claim 9 only requires a specific soaking before cleaning. Thus, claim 9 would not be specifically limited to the cleaning condition set forth in claim 1.

As the Examiner has noted, claim 10 is dependent upon claims 1 or 9 (as well as claims 3, 5, or 7). Claim 10 further limits claim 1 by requiring the soaking step. Again, as noted above, claim 9 is not limited to the specific cleaning step set forth in claim 1. As such, claims 9 and 10 do not stand or fall together for the reasons set forth in the Appeal Brief and the above reasons.

Applicants' comments corresponding to the Examiner's items (1) - (3) in regard to the rejection of claims 1 and 5 over the combination of *Miyashita et al.* and *Kanno* are summarize below.

(1) The Examiner is combining the prior art disclosure of *Miyashita et al.* with the invention of *Miyashita et al.* improperly. On the one hand, the Examiner relies upon the prior art description of *Miyashita et al.* for a teaching of bringing roll-like brushes into contact with a semiconductor wafer, whereas the invention of *Miyashita et al.* does not bring roll-like brushes into contact with the semiconductor substrate. The teachings of *Miyashita et al.* would have motivated one of ordinary skill in the art to arrange roll-like brushes to sandwich the semiconductor substrate not to be in contact therewith. Therefore, contrary to the Examiner's assertions, and consistent with the arguments presented in the Appeal Brief, *Miyashita et al.* would not have motivated one of ordinary skill in the art to bring a sponge member into contact

with the object to be cleaned while supplying water containing carbon dioxide gas having a resistivity value of less than 5MΩ.

The Examiner also incorrectly construes the emphasis of "supplying" as "directly supplying." The emphasis in the Appeal Brief is on the words "contact" and "while supplying." As noted above, *Miyashita et al.* would not have motivated one of ordinary skill in the art to bring a sponge member into contact with the object to be cleaned while supplying the cleaning water.

(2) The Examiner comments that applicants have not attacked the motivation for making the combination. The Examiner is correct. However, the Examiner now is combining the prior art of *Miyashita et al.* and the invention of *Miyashita et al.* As such, applicants now traverse the motivation to combine the references.

As noted above, *Miyashita et al.* would not have motivated one of ordinary skill in the art to bring a sponge member into contact with the object to be cleaned while suppling water containing carbon dioxide gas having a resistivity value of less than 5MΩ. One of ordinary skill in the art would not have combined the prior art disclosure of *Miyashita et al.* with the invention of *Miyashita et al.* as asserted by the Examiner.

(3) The Examiner now provides criticism of the Declaration and argues that the "declaration is grossly deficient and fails to provide any meaningful data because it recites substantive limitations which simply do not exist in the claims." The Examiner lists four reasons (labeled a-d).

In regard to (a), the Examiner argues that the claims do not specify "superpure water." The Examiner reasons that a higher resistivity is a purer water and the instant claims are drawn to a lower resistivity suggesting less pure water. The Examiner's reasoning is flawed. The

Declaration clearly shows that the resistivity is adjusted by adding carbon dioxide gas. In other words, superpure water has a particular resistivity which is adjusted by the addition of carbon dioxide gas.

In regard to item (b), the Examiner argues that changes in the flow rate will have an impact on the particle removal rate. Again, the Examiner does not appear to understand that the resistivity is obtained by adjusting the flow rate.

In regard to item (c), the Examiner argues that the resistivity could be achieved in a different manner. It is believed that this point is irrelevant since the Declaration shows unexpected results with water containing carbon dioxide gas having a resistivity value of less than 5MΩ.

Lastly, in item (d), the Examiner argues that the claims are not limited to the specific substrate in the claims. Again, the position of the Examiner is unreasonable and there is no suggestion that use of different substrates would provide different results.

The Examiner also points out that *Takehiko et al.* discloses "the system and results that are set forth in the Declaration." However, *Takehiko et al.* is not applied in this specific rejection.

The Examiner provides his response to the rejection of claims 1 and 5 over the combination of *Miyashita et al., Kanno,* and *Takehiko et al.* beginning on page 14 of the Examiner's answer.

One must look at what the combined teachings of the prior art would have suggested to one of ordinary skill in the art. In this regard, if one of ordinary skill in the art would have combined the references, the references would be combined so that the roll-like brush does not

contact the semiconductor substrate, as taught by *Miyashita et al.* Furthermore, *Takehiko et al.* would not have motivated one of ordinary skill in the art to supply its ultra-pure water to a sponge member since *Takehiko et al.* only teaches use of the water in a final process of cleaning, not in cleaning using a brush.

Page 16 of the Examiner's answer comments on the arguments with respect to the combination of *Miyashita et al., Kanno*, and *Simmons et al.* The Examiner comments that the Declaration conceded that a brush is equivalent to a sponge. There is no such concession made in the Declaration. The Declaration states "one brushing cleaning step" which the Examiner has interpreted as a concession that a brush is the same as a sponge member.

The Examiner also comments that *Simmons et al.* teaches that the brush is separated from the wafer. The Appeal Brief did not disagree. The arguments in the Appeal Brief emphasized that *Simmons* does not teach separating the wafer during cleaning.

Pages 17 and 18 of the Office Action provide the Examiner's response to the arguments based on the combination of *Miyashita et al., Kanno, Takehiko et al.,* and *Simmons et al.* Again, the references must be considered in their entirety in what they would suggest to one of ordinary skill in the art.

Page 19 comments on the arguments with respect to the combination of *Miyashita et al., Kanno, Simmons et al.* and *Chung et al.* The Appeal Brief noted that there is no teaching or suggestion of performing the claimed soaking prior to cleaning. The Examiner has not explained why *Chung et al.* would have motivated one of ordinary skill in the art to perform the claimed soaking before cleaning.

Page 20 of the Examiner's answer comments on the combination of *Miyashita et al.,*

Kanno, Simmons et al., Takehiko et al., and *Chung et al.* Again, the Examiner has failed to explain why *Chung et al.* would have motivated one of ordinary skill in the art to perform the claimed soaking before cleaning.

For the reasons above and the reasons set forth in the appeal brief, the Honorable Board is respectfully requested to reverse the rejections of the Examiner.

In the event that any additional fees are due in connection with this paper, please charge our Deposit Account No. 01-2340. A duplicate copy of this paper is enclosed.

Respectfully submitted,

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23850
PATENT TRADEMARK OFFICE

PTO: 2002-1294

Japanese Published Unexamined Patent Application (A) No. 04-206724, published July 28, 1992; Application Filing No. 02-337259, filed November 30, 1990; Inventor(s): Takehiko Tani et al.; Assignee: Hitachi Wires and Cables; Japanese Title: Semiconductor Wafer Cleaning Method

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SEMICONDUCTOR WAFER CLEANING METHOD

CLAIM(S)

A method to clean a semiconductor wafer with ultra pure water in the final step of cleaning the semiconductor wafer, wherein is used a solution whose resistivity value is adjusted to 0.1 - 3.0 MΩ cm by adding an electrolyte into said ultra pure water.

DETAILED DESCRIPTION OF THE INVENTION

(Field of Industrial Application)

The present invention pertains to a cleaning method using ultra pure water in the cleaning process of chemical compound semiconductor wafer; by dissolving a proper amount of electrolyte in ultra pure water, a proper cleaning solution is prepared to clean a wafer.

(Prior Art)

Semiconductor wafers are cleaned, after mechanochemical polishing, with an organic solvent, such as ethanol, methanol, and acetone, surfactant, and a weak etching solution.

In the last step of cleaning, cleaning is always done by ultra pure water.

Also, even after the wafer is processed, ultra pure water cleaning is performed to remove a wet-etching solution in the process of forming an element on a wafer surface.

With the ultra pure water used for this purpose, the bacteria, electrolyte, and foreign substances are removed by a reverse osmosis film, ion exchange resin, and filter, and its resistivity is 17 - 18 MΩ cm.

(Problems of the Prior Art to Be Addressed)

The impurity of the electrolyte component in the ultra pure water is removed to a minimal value by passing it through an ion exchange resin in multiple steps. The electrical resistance in the ultra pure water is determined by H+, OH-, and a slight electrolytic dissociation. The logical resistance value in the ultra pure water at this time is 18. 3 MΩ, and in an actual cleaning method also, 7 - 18 MΩ ultra pure water is used.

A normal cleaning operation is done at 2 - 10/min flow rate in an up-flow type cleaning tub. In this case, the semiconductor wafer to be cleaned collides with ultra pure water having 17- 18 MΩ of high resistance, is electrified by friction, and attracts foreign substances electrostatically during and after the cleaning. Therefore, in the prior art method, attachment of foreign substances is unavoidable. The foreign substances attached to the surface of the wafer significantly undercut

the characteristics and yield of a device formed on the wafer surface.

To prevent the electrification of the wafer during the cleaning using ultra pure water, an attempt was made to reduce the resistivity in the ultra pure water. However, if the resistivity is reduced, the wafer surface is roughened by an etching operation, so it was essential to find an optimal resistivity value.

The objective of the present invention, to solve the drawbacks of the prior art, is to present a cleaning method that can prevent the attachment of foreign substances while preventing the wafer surface from being roughened.

(Means to Solve the Problems)

A method to clean a semiconductor wafer with ultra pure water in the final step of cleaning the semiconductor wafer, wherein is used a solution whose resistivity value is adjusted to 0.1 - 3.0 MΩ cm by adding an electrolyte into said ultra pure water.

(Operation)

The performance of the wafer to be cleaned is controlled by the resistivity value of the ultra pure water used for cleaning the wafer.

By presetting the resistivity value at 0.1 - 3.0 MΩ cm by adding a highly pure solution to ultra pure water, a cleaning method, wherein the electrification of wafer surface and attachment of foreign substances can be prevented, can be established.

(Embodiment Example)

The cleaning method of a semiconductor wafer of the present invention and its effect are explained below.

The non-doped GaAs wafer (diameter: 75 mm) is, after the mechanochemical polishing process, put to ultrasonic wave cleaning in an organic solution, such as that of methanol or acetone.

Subsequently, it is cleaned with a GaAs cleaning solution and then is cleaned with ultra pure water. This ultra pure water is preliminarily treated with a reverse osmosis film, ion exchange resin, active carbon, and filter in a dedicated device.

After said ultra pure water is filled in the tub and before the GaAs wafer is immersed, highly pure carbon dioxide (CO_2) is bubbled to reduce the resistivity of ultra pure water, and finally, the GaAs wafer is cleaned.

To examine the relationship between the resistivity value of the ultra pure water and wafer surface condition, the following experiment was conducted.

By changing the resistivity value of the ultra pure water to 0.005 - 18. 0 MΩ cm, the amount of said carbon dioxide is controlled. Then, the number of foreign substances on the wafer surface and the surface condition are examined relative to each resistivity value. The table shows the result of the experiment.

The table indicates the relationship among the resistivity of the ultra pure water, wafer surface condition, and the number of foreign substances.

particle size resistivity (MΩ cm)	Number of foreign substances			wafer surface condition
	0.1 μm	0.1 - 0.5 μm	70.5 μm	
0.005	5	0	0	roughness on the surface
0.05	5	0	0	roughness on the surface
0.1	5	0	0	excellent
3.0	5	0	0	excellent
3.5	15	2	0	excellent
18.0	60	10	3	excellent

The wafer after the cleaning was dried by using an isopropyl steam dryer. To examine the wafer surface, a mirror surface inspection device was used.

As shown in the table, when the resistivity was 18 MΩ cm, there were 60 foreign substances having particle diameter 0.1 μm, 10 foreign substances with 0.1 - 0.5 μm particle size, and 3 foreign substances with 0.5 μm size. But, as the resistivity declined, the number of the foreign substances decreased.

More specifically, when the resistivity was 3. 0 MΩ cm or less, there were only 5 foreign substances having particle diameter 0. 1 μm, and the following were confirmed.

1) Reducing the resistivity of the ultra pure water can prevent the attachment of the foreign substances.

2) When the particle diameter is 0.05 or less, roughness is generated on the

wafer surface, which is not preferable.

The ultra pure water was found to be optimal for cleaning when the resistivity is 0.1 - 3. 0 μm.

As a method to reduce the resistivity of ultra pure water, in stead of carbon dioxide, boron compounds, e.g., B_2O_3, $B(CH_3)_3$, arsenide, e.g., A_6H_3, or gallium compound, e.g., Ga $(CH_3)_3$, can be added.

In this embodiment example, the semiconductor to be cleaned is III-V group compound, GaAs, but InP can be used, too. Also, II - VI group compound semiconductor, CdTe, may be the semiconductor to be cleaned.

(Advantage)

By this invention, the following advantages can be presented.

1) A high quality wafer with no foreign substances attached can be produced.

2) A high quality device can be manufactured by the improved wafer quality.

3) Accordingly, yield in manufacturing the wafers and devices can be dramatically improved, which is advantageous in raising productivity.

Translations
U. S. Patent and Trademark Office
2/01/02
Akiko Smith